CLAIMS

1. A sample analysis apparatus that measures an amount of at least one component in a sample comprising:

(i) a microwave generator that generates a continuous linearly sweeping microwave signal varying in frequency;

(ii) a microwave transmitter that transmits the generated signal;

(iii) a microwave receiver that receives the transmitted signal;

(iv) at least one microwave analyser that generates an output signal, which is operatively connected to the microwave transmitter and to the microwave receiver; said output signal indicating phase and/or amplitude differences between the generated signal and the received signal;

(v) means for determining a depth of the sample located between said microwave transmitter and said microwave receiver; and

(vi) a processor that determines the amount of said at least one component in said sample from said depth and said output signal.

2. The apparatus of claim 1 wherein said means for determining a depth of the sample comprises a sample depth analyser that measures depth of the sample.

3. The apparatus of claim 2 wherein the sample depth analyser is an ultra-sonic transmitting device.

4. The apparatus of claim 1 wherein the continuous linearly sweeping microwave signal varies in frequency between a range of about

0.10 GHz to 4.00 GHz.

5. The method of claim 4 wherein the continuous linearly sweeping microwave signal varies in frequency between a range inclusive of 1.25 GHz to 1.65 GHz.

6. The apparatus of claim 1 wherein the transmitter and receiver comprise respective antennas.

7. The apparatus of claim 1 wherein the microwave analyser comprises a microwave mixer that measures phase shift by receiving a portion of the transmitted signal and a portion of the received signal.

8. The apparatus of claim 7 wherein the microwave mixer generates an output signal comprising an oscillating voltage with a DC bias wherein a change in the DC bias is proportional to a change in velocity of the transmitted signal and provides a measure of a change in overall dielectric constant of the component in the sample.

9. The apparatus of claim 1 wherein the microwave analyser comprises a microwave amplitude detector that measures an amplitude of the received signal.

10. The apparatus of claim 1 wherein phase shift and/or attenuation of the amplitude of the microwave signal is measured by random stratified sampling of the received signal.

11. The apparatus of claim 10 wherein the random stratified sampling is performed using an algorithm programmed into the processor.

12. The apparatus of claim 1 wherein the processor is a microprocessor.

13. The apparatus of claim 1 wherein the component in the sample is water, carbon, salt, fat or protein.

14. The apparatus of claim 13 wherein an amount of water in the sample is determined using the equation:

Moisture content = M0 +M1*(Attenuation/Depth of sample) + M2*(Velocity/Depth of sample)+M3*(Velocity/ Depth of sample)^2 + M4*(Attenuation/ Depth of sample)^2; wherein

Attenuation = (amplitude measured with sample) - (amplitude measured without sample);

Velocity = (microwave velocity measurement with sample) – (microwave velocity measurement without sample); and

Depth of sample = (Depth with sample) - (depth without sample); and

M0, M1, M2, M3 and M4 are calibration coefficients determined by performing a simple linear regression of variables: (Attenuation/Depth of sample), (Velocity/Depth of sample), (Velocity/ Depth of sample)^2 and (Attenuation/ Depth of sample)2 against experimentally determined values for the component.

15. The apparatus of claim 14 wherein M0 = 0.475, M1 = 208.117, M2 = -0.04454, M3 = 0 and M4 = 0.

16. A method for measuring an amount of at least one component in a sample including the steps of:

(1) generating a continuous linearly sweeping microwave signal varying in frequency;

(2) transmitting the generated signal;

(3) receiving a received signal;

(4) measuring and analysing the generated signal and the received signal and generating an output signal; said output signal indicating phase and/or amplitude differences between the generated signal and the received signal;

(5) measuring a depth of the sample to provide a sample depth measurement; and

(6) processing the output signal and the sample depth measurement to determine the amount of the component in the sample.

17. The method of claim 16 wherein the continuous linearly sweeping microwave signal varies in frequency between a range of about 0.10 GHz to 4.00 GHz.

18. The method of claim 17 wherein the continuous linearly sweeping microwave signal varies in frequency between a range inclusive of 1.25 GHz to 1.65 GHz.

19. The method of claim 16 wherein the steps of transmitting and receiving signals is by respective antennas.

20. The method of claim 16 wherein phase shift is measured by a microwave mixer that receives a portion of the generated signal and a portion of the received signal.

21. The method of claim 20 wherein the output signal comprises an oscillating voltage with a DC bias that is proportional to both a change in microwave velocity and phase shift.

22. The method of claim 16 wherein attenuation of an amplitude of the generated signal is measured by an amplitude detector.

23. The method of claim 16 wherein the phase and/ amplitude differences are measured by random stratified sampling of the received signal.

24. The method of claim 23 wherein the random stratified sampling is performed using an algorithm within a processor.

25. The method of claim 16 wherein the step of measuring a depth of the sample is by an ultra-sonic means.

26. The method of claim 16 wherein the processing is performed by a microprocessor.

27. The method of claim 16 wherein the component in the sample is water, carbon, fat, salt or protein.

28. The method of claim 27 wherein an amount of water in the sample is determined using the equation:

Moisture content = M0 +M1*(Attenuation/Depth of sample) + M2*(Velocity/Depth of sample)+M3*(Velocity/ Depth of sample)^2 + M4*(Attenuation/ Depth of sample)^2; wherein

Attenuation = (amplitude measured with sample) - (amplitude measured without sample);

Velocity = (microwave velocity measurement with sample) – (microwave velocity measurement without sample); and

Depth of sample = (Depth with sample) - (depth without sample); and

M0, M1, M2, M3 and M4 are calibration coefficients that are determined by performing a simple linear regression of the variables: (Attenuation/Depth of sample), (Velocity/Depth of sample), (Velocity/ Depth of sample)^2 and (Attenuation/ Depth of sample)^2 against experimentally determined values for the component.

29. The method of claim 28 wherein M0 = 0.475, M1 = 208.117, M2 = -0.04454, M3 = 0 and M4 = 0.

30. Use of the apparatus of claim 1 to determine an amount of at least one component in a sample.

31. Use of the apparatus of claim 30 wherein the at least one component modifies the generated signal.

32. Use of the apparatus of claim 31 wherein the at least one component is water, carbon, salt, fat or protein.

33. Use of the apparatus of claim 30 where the sample is an ore, mineral, coal, flyash, nickel ore, alumina; chromium ore, wood chip; bulk food, textile, chemical, food product, sugar, pasta, coffee, peanuts, wheat, barley, beef jerky, kitty litter, paper, polystyrene or plastic.